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CENTRALIZATION vs DECENTRALIZATION OF INFORMATION SYSTEMS: AN ANNOTATED BIBLIOGRAPHY

by

John Fralick Rockart
and
Joav Steve Leventer

REPORT CISR-22
SLOAN WP 844-76

April 1976

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The field of Distributed Processing is eliciting a great deal of interest at the current time. The first task undertaken by the CISR research project on Distributed Processing was one of searching and culling the literature. An annotated bibliography, representing the results of this search, is presented below.

Four classes of articles are surveyed, under the headings:

- Centralization vs. Decentralization: Issue Discussions
- Distributed Systems and Computer Networks
- Distributed Data Bases
- Organizational Issues

Articles which we found to be of most interest (for our specific purposes) are marked by an *.

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I. Centralization vs. Decentralization: Issue Discussions

Albrecht, Leon K. : Organization and Management of Information Processing Systems, McMillan, 1973.

This book surveys the general area of information systems management and organization. pp. 115-120 deal specifically with issues of Centralization-Decentralization, stressing in particular organizational and human factors.

Burnett, Dr. G.J. : "Computer Options: Large Centralized Computer vs. Minicomputers" Unpublished manuscript, Index Systems, Inc., 1972.

A discussion of the use of minis as stand alone machines and as parts of larger systems. Provides also a comparison of large machines and minis along the dimensions of hardware, software, costs, reliability, and manufacturers support.

Burnett, Gerald J. and Nolan, Richard L. : "At Last, Major Roles for Minicomputers" Harvard Business Review, May-June 1975.

Surveys briefly reasons and disadvantages of centralization and presents a good table of technical comparison of computers (large, medium, and mini) along hardware and software dimensions. Describes four configurations of computers, ranging from no use of minis to use of minis exclusively.

* Canning, Richard G. : "Are We Doing the Right Things?" EDP Analyzer, Vol. 13, No. 5, May 1975.

In this, the first in a series of four reports dealing with the economics of data processing, Canning discusses the choice and prioritization of D.P. projects. Three forms of organization for this decision are discussed (along with examples): Division-Level decision and Division-Level implementation; Division-Level decision and Corporate-Level implementation; and Corporate-Level decision and implementation. The article touches on some of the major issues in the management of information systems.

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* Articles which we found to be of most interest (for our specific purposes) are marked by an *.

Erikson, Warren J. : "Determining the Optimal Degree of Computer System Centralization" Working Paper No. 33-1, School of Business Administration, University of Souther California, L.A., 1973.

An attempt to determine mathematically, based on queueing theory, "Whether a multiple computer installation is cost-effective relative to a single computer installation". The model developed in the paper relates exclusively to hardware issues, but includes the issue of communications costs between separate physical locations. Includes surveys to determine ranges of values for model parameters.

Fredericks, Ware A. : "A Case for Centralized EDP" Business Automation, January 1972.

Explains the trend towards centralization in terms of desire for standardization, growth of application complexity, and shortage of EDP personnel. Reviews current centralization practices (trends), and suggests a specific organization of the centralized EDP "which resembles in miniature, the structure of the environment which it is established to serve". The functions within the "management services" department are suggested as: -business systems application, systems projects, EDP operations, training and standards, administrative services.

* Glaser, George : "The Centralization vs. Decentralization Issue: Arguments, Alternatives and Guidelines: Data Base 2(3), 1970, pp. 1-7.

Centralization vs. Decentralization of staff, equipment and authorities is discussed. Arguments for centralization include economies of scale, better control on Co. and EDP dept., availability of qualified personnel. Arguments for decentralization: familiarity with local problems, response to needs, local responsibility. Hardware and personnel developments which favour decentralization are mentioned. States seven criteria for determining policy. Guidelines for allocating tasks to central and division tasks are provided, with the underlying principle of local responsibility.

Grosch, Herbert : "Grosch's Law Revisited" Computerworld, April 16, 1975, p. 9.

Grosch's rebuttal to those who argue that minicomputers have made his now-famous law obsolete. He re-states the law in its original form ("Economy is as the square root of the speed: if you want to do it twice as

cheaply you have to do it four times as fast"), and suggests that the law proved correct because of the nature of the behavior of professional users, as well as its use in pricing. Grosch concludes that: "As long as we have greedy salesmen and ... programming, most of the power of even the cleverest machines will be wasted".

Gruenberger: Fred and Babcock, David — "Speaking of Minis" Datamation, July 1973, pp. 57-59.

Following a brief description of minis, the authors argue strongly that "An idle computer is not necessarily a bad thing" and try to show that the use of minis may well be more useful and less expensive than using a time-sharing service.

Humfrey, Robert D. : "The Organizational Side of Centralized EDP Services" Management Control, 21:11-3, January 1974.

Concentrates on organizational issues of centralization. Includes advantages of centralization, and some basic difficulties. Argues for centralization, but suggests some precautions.

* Lassoff, D.A. : "Management Considerations: Centralization vs. Decentralization of EDP Resources" Guide 38, v. 2, 1974, pp. 472-487.

Presents a study of a group of executives, "geared to produce points for consideration" on the subject. Four environments compared: all combinations of centralization -decentralization of computer resources, and centralization-decentralization of development personnel. No conclusion is offered.

Lowe, Ronald L. : "The Corporate Data Center: Getting It All Together" Computer Decisions, May 1973.

Presents the steps and alternatives towards "consolidating" the company's EDP activities. A seven step consolidation plan is presented. Main advantages and dangers of centralization are discussed.

* Norton, David P. : "Information System Centralization: The Issues" Harvard Business School Paper, 9-172-286, 1972.

Summarizes arguments made mostly by other authors. Paper organized by: system operation, system development, system management.

Streeter, D.N. : "Centralization or Dispersion of Computing Facilities: IBM Systems Journal, No. 3, 1973.

Attempts to quantify economic and some behavioral aspects of centralization. Proposes a cost model which includes reliability considerations. Employs queueing theory to look into the service-quality questions. Recognizes behavioral and other subjective issues which draw towards decentralization, suggesting measurements of "cost of compartmentalization". Uses many simplifying assumptions.

* Withington, Frederic G.: The Organization of the Data Processing Function, Section 7: Multicenter Networks, Wiley Business Data Processing Library, 1972, pp. 69-79.

An overview of the issues and possible solutions. Details four forces causing centralization (cost of duplicate system development, desirability of standard equipment, desire for uniform management reporting, shortage of expert personnel) and organizational issues leading to decentralization. Surveys common alternatives and compromises, including a "satellite system". The influence of the parent organization's authority structure and the effects on the parent organization are discussed.

Withington, Frederic G.: "Crystal Balling: Trends in EDP Management", Infosystems, Volume 20, January 1973.

A shortened, somewhat watered-down version of the same author's "The Organization of the Data Processing Function" - Section 7.

Wofsey, Marvin M. : "Centralization vs. Decentralization" in Wofsey: Management of ADP Systems, Chapter 2, Auerbach 1973, pp. 26-38.

Another discussion of the argument pro and con centralization. Leans towards centralization for economic reasons. Short discussion of the military command and control system.

II. Distributed Systems and Computer Networks

Amstutuz, Stanford R. : "Distributed Intelligence in Data Communications Networks", Computer, November-December 1971, pp. 27-32.

An analysis of the ways in which the addition of a minicomputer can reduce the cost of a computer/communication network. The author suggests two places where such a mini could be positioned: at the central site, taking load off the larger computer, and at a remote site, as a message concentrator. Advantages obtainable from both configurations are discussed.

Canning, Richard G. : "The Emerging Computer Networks", EDP Analyzer, January 1973.

Discusses the importance to the whole D.P. field of computer networks such as the ARPANET and TYMNET.

Canning, Richard G. : "Distributed Intelligence in Data Communication", EDP Analyzer, February 1973.

Discusses the use of minicomputers as front end processors in data communication. Three case studies presented. Some arguments against distributed systems rebutted.

* Canning, Richard G. : "In Your Future: Distributed Systems?", EDP Analyzer, August 1973, Vol. 11, No. 8.

A good and thorough article, discussing distributed processing, its advantages, disadvantages, problems, and current state. Four major components of distributed systems identified as: distributed processing, distributed communications, distributed data bases, and system wide rules. Predicts that distributed systems will be the rule by 1980.

* Canning, Richard G. : "Structure for Future Systems", EDP Analyzer, August 1974, Vol. 12, No. 8.

Discussion of three alternative structures: centralized, hierarchical distributed and network distributed. Technological trends and their effects are analyzed. Recommends preparing for the new structures now. Predicts IBM's support of hierarchical networks. Two case studies presented.

Chen, Tien Chi : "Distributed Intelligence for User Oriented Computing" AFIPS, Vol. 41, Part II, Fall 1972, pp. 1049-1056.

A highly technical paper, arguing that new LSI technology facilitates distributing logic-memory systems, creating "loosely-coupled polycentric computing systems". Such systems would be more efficient and more user oriented, allowing, in particular, efficient interpretive processing.

Coleman, Michael L. : "ACCNET - A Corporate Computer Network", AFIPS, Vol. 42, 1973, pp. 133-130.

A description of a specific networking of a DEC 10 with an IBM 370/165. Includes a short description of other implemented networks, advantages of networks, and a 56 item bibliography.

David, Jon : "Role of the Minicomputer", Data Management, February 1975, pp. 16-19.

Surveys the development of minis, discusses distributed data processing systems (several examples) and suggests guidelines for getting a minicomputer.

Edited : Datamation, February 1975, pp. 40-56.

This issue includes four articles describing four different network configurations. The articles are technical, but give a good overview of the range of possibilities available with present "state of the art" technology.

* Edited : "Distributed Computing: A Growing Concept", Infosystems, August 1975.

A survey of the points of view of several hardware manufacturers associated with the distributed processing idea (DEC, H-P, etc.). The article is appended by an excerpt from an address "A Business Approach to Improving Productivity in the Service Sector", by R.B. White, Executive V.P., First National City Bank, New York.

* Farber, D.J. : "A Survey of Computer Networks", Datamation 18, 4 (April 1972), p. 36-39.

Gives a good overview of types of networks existing today, their features and problems.

Farber, David J. : "Software Considerations in Distributed Architectures", Computer, March 1974, pp. 31-35. (From 1973 Lake Arrowhead Workshop).

Surveys briefly the issues of interprocess communication, protection, resource management, and distributed file systems. Gives examples of systems operating with the above characteristics.

* Hobbs, L.C. : "The Rationale for Smart Terminals", Computer, November-December 1971, pp. 33-35.

A short paper arguing for moving processing power closer to the user (while retaining the data-base centrally). Suggests guidelines for the degree of decentralization of "intelligence".

* Joseph, Earl C. : "Innovations in Heterogeneous and Homogeneous Distributed-Function Architectures", Computer, March 1974, pp. 17-24. (From Lake Arrowhead Workshop).

Gives a technical survey of types of networks and distributed architecture machines, their characteristics, advantages, etc. Includes summary outlines of the above.

* Kneppelt, Leland R. : "A Simple Distributed Approach to Manufacturing Information Systems", AFIPS, Vol. 43, 1974, pp. 485-490.

Describes an actual implementation of a distributed system. On-line applications - current status and control information systems - were implemented on a minicomputer. Large batch applications, such as long range planning and manufacturing standards maintenance, were implemented on a maxi. Files were distributed between the two systems, with some duplicate information, and some duplicate files.

* Markowitz, Joseph : "A Large Computer Looks at the Distributed Computing Problems", Behavior Research Methods and Instrumentation, Volume 6, No. 2, 1974, pp. 237-240.

Suggests that the facilities needed to complement small laboratory minicomputers could be supplied remotely by a large machine via telecommunication. Proposes three major areas where the large computer can give such service: remote hardware peripherals, applications software (e.g. complex data management and data analysis programs), and programming aids for the small machine.

Describes partial implementation of the "Consistent System" at MIT.

Marshall, Joseph C. : "Distributed Processing on Wall Street, Datamation, July 1973, pp. 44-46.

Describes a mini-network for on-line inquiry and updating implemented by Bunker-Ramo Corp. The network, called Telequote III, is used for informing stock brokers around the country of current stock process. The newer version of this system, Market Decision System 7 (MDS-7) is also described.

Peck, Paul L. : "Effective Corporate Networking, Organization, and Standardization", AFIPS, Vol. 39, Fall 1971, pp. 561-569.

Deals with networking of multiple ADP centers within one corporation. Mentions some advantages, and proposes principles for management and setting standards for corporate ADP networks.

Riley, Wallace B. : "Minicomputer Networks - A Challenge to Maxicomputers?" in A Practical Guide to Minicomputer Applications, Fred F. Coury, pp. 103-109, reprinted from Electronics, March 28, 1971.

This article, written by the computer editor of Electronics, surveys mini-networks and expert opinions on their advantages and uses. The ability to tailor the computer network to the particular job, along with cost-effectiveness, are mentioned as the major advantages. On the other hand, some experts mention the mini's inferiority in large calculations and data base handling.

Robbins, Clark : "Distributed Data Processing", Data Management, September 1975.

A somewhat disorganized discussion, arguing that the time of distributed processing has come. Robbins discusses four levels in the distributed network: a large data utility, a satellite computer, the intelligent terminal and the terminal, claiming that "the processing power at these levels is and will continue to increase in a dramatic fashion". The article's major claim is that total cost per terminal/month is a good measure of the efficiency of computer systems, and that distributed systems are superior in this measure to time-sharing systems.

Shatz, Vernon : "Computer Networks for Retail Stores", Computer, April 1973.

A case study of a mini network implemented in a group of supermarket chains. Emphasis on the in-stores applications (P.O.S., etc.), and a separate communications-oriented system for ordering and other functions on a chain-wide basis.

Speers, G.S. : "Monitoring/Control by Distributing Computing", Datamation, July 1973, pp. 47-49.

A case study of a network of 45 computers controlling a Canadian/U.S. oil pipeline that transports over one million barrels a day. The network, composed of one host (PDP 10) and 44 control minicomputers (PDP 8), is connected in a star pattern. It controls a total of 71 pumping stations by start/stop decisions, and monitoring several variables.

Yoshizawa, K., Yasumatsu, N., Yoshida, T., Yamada, E., and Tanaka, T. : "Minicomputer Complex Systems", First USA-Japan Computer Conference, 1972, Session 15-4-1, pp. 480-485.

A highly technical description of a mini-network implemented at the Japan Racing Association for a horse-betting information system. The network, which features "function-sharing" and "load-sharing", is shown to be superior to large computer systems in both cost-performance and cost-reliability.

III. Distributed Data Bases

* Booth, Grayce M. : "The Use of Distributed Data Bases in Information Networks", First International Computer Communication Conference Proceedings, 1972, pp. 371-376.

  Presents an overview of theories concerning data base creation and use within a computer network. Includes alternative methods for creating a distributed data base, how to match up jobs with the correct files, problems of allowing a single application to access files at several locations, and the problem of protecting file and system integrity.

* Mantey, Patrick E. and Carlson, Eric D. : "Integrated Data Bases for Municipal Decision-Making", AFIPS, Vol. 44, 1975, pp. 487-493.

  Shows that, in a municipal setting, it is possible by means of "extraction" for "properly structured" files on different computer systems to gain most of the advantages of a data base maintained on a single computer. These IBM authors therefore provide a case which suggests that in some settings, one of the major factors favoring large centralized computers, the ability to maintain a large central data base, can be handled just as well in the decentralized situation.

* Rosenthal, D.B. : "The Distributed Data Base Concept", Guide 35, 1972, pp. 276-288.

  Advocates distributed data bases in hierarchical systems. Reviews pros and cons of both distributed and centralized data bases. Stresses the emergence of cost/effective minis, and behavioral and reliability advantages of distributing.

IV. Organizational Issues

* Argyris, Chris : "Management Information Systems: The Challenge to Rationality and Emotionality", Management Science, Vol. 17, No. 6, February 1971, pp. B-275 - B-292.

"If management information systems achieve their designed highest levels of aspiration, they will tend to create conditions where executives will experience (1) reduction of space of free movement, (2) psychological failure and double bind, (3) leadership based more on competence than formal power, and (4) decreased feelings of essentiality. These experiences will tend to create genuine resistance to MIS. MIS specialists, in turn, are not presently equipped to cope with the emotional problems caused by their systems. They react over rationally...."

* Beckhard, Richard : "Strategies for Large System Change", Sloan Management Review, Winter 1975.

This article explores the topic of the successful implementation of organization change in large systems. Beckhard begins by describing a model of change planning applicable to large and complex organizations. He then focuses on five specific intervention strategies which may be required in actual organization settings. The article concludes with an examination of where in the organization to begin a change effort and how to maintain change once successfully initiated.

* Canning, Richard G. : "Do We Have the Right Right Resources?", EDP Analyzer, Vol. 13, No. 7, July 1975.

This report, the third in a four-part series on the economics of data processing, includes a discussion of the needs for thorough planning of the EDP activity, and proposes a format for such a planning process.

Deaden, John and Nolan, Richard L. : "How to Control the Computer Resource", Harvard Business Review, Nov.-Dec. 1973, pp. 68-78.

Includes an analysis of the differences between the computer resource and other staff activities. Concentrates on the pricing mechanism of the EDP department, comparing nonchargeout, full chargeout, any partial chargeout. Suggests a framework for the design of the charging method.

* Demb, Ada B. : "Centralized versus Decentralized Computer Systems: A New approach to Organizational Impacts", CISR working paper, Number

This paper, based on the author's Ph.D. thesis, develops a framework for analyzing the impacts of management information systems on an organization. The framework, based on the discipline of organizational development, includes looking at planned change and at internal organization dynamics. The paper includes, in addition, an excellent summary of predictions identified in the information systems literature concerning organizational effects of centralization/decentralization.

* Goggin, William C. : "How the Multidimensional Structure works at Dow Corning", Harvard Business Review, January-February 1974.

One emerging solution to the Centralization-Decentralization issue is the matrix structure. This article describes the implementation of a complex matrix structure at Dow Corning, it underlying philosophy, its use by manage ment, and its advantages and disadvantages.

* Grobstein, David L. and Uhlig, Ronald P. : "A Wholesale Retail Concept for Computer Network Management", AFIPS, Vol. 41, Fall 1972, pp. 889-898.

Proposes a conceptual separation between the "wholesale computing facility", whose task is to provide computing power in several "grades", and the "retail computing facility" whose task is to tailor applications to the user's needs. This separation, say the authors, would be beneficial in "identifying a viable management structure for pooling computer resources across major organizational boundaries" (into computer networks).

* Hebden, J. E. : "The Importance of Organizational Variables in the Computerization of Management Information Systems", Journal of Management Studies, Vol. 8, No. 2, 1971, pp. 179-198.

Discusses three organizational variables with direct influence on the computer activity: technology, the nature of the product and its market, and geographical and social location of the organization. Concludes with the predicted impact on EDP and the nature of EDP staff and organization.

Hofer, Charles W. : "Emerging EDP Patterns", Harvard Business Review, Vol. 48, March-April 1970, p. 16.

Details changes brought about by the computer in two

organizations. Changes in organizational structure and process are described and analyzed. Includes comparison with previous predictions and the author's expectations for future changes.

* Kolb, David A. and Frohman, Alan L. : "Organizational Development Through Planned Change: A Development Model", Sloan School of Management Working Paper 453-70, 1970.

Proposes a model for process consultation, based on seven stages: Scouting, Entry, Diagnosis, Planning, Action, Evaluation and Termination. Discusses each stages, its objectives, requirements, participants, problems, etc.

* Lucas, Henry C. : "The Problems and Politics of Change: Power, Conflict and the Information Services Subunit", in Gruenberger, F. (Ed.): Effective vs. Efficient Computing, Prentice Hall, 1973, pp. 81-103.

Shows that the information services subunit accumulates a great deal of power, which combined with user frustration and lack of understanding of the technology, leads to conflict. This conflict can drastically reduce the ability of the information services department to function. Offers suggestions for minimizing the problems created by the change effort in the four major components of systems design.

Meyer, Marshall W. : "Automation and Bureaucratic Structure", in Porter, D.E., et.al., Studies in Organizational Behavior and Management, Intext Educational Publishing, 1971.

Discussion of effects of automation on formal organizational structures. Based on a study of a large number of municipal and state institutions.

Rubenstein, Albert H. et.al. : "Some Organizational Factors Related to the Effectiveness of Management Science Groups in Industry", Management Science, Vol. 13, No. 8, April 1967, pp. B-508 - B-518.

The organizational factors which can influence the management science activity are discussed. These factors include the level of management support, client receptivity, organizational and technical capability of the MS group, organizational location, etc. Particular importance is given to the level of "establishment" of the group, as defined in terms of four life cycle phases. A case study is presented to support the hypotheses.

* Zannetos, Zenon S. and Sertel, Murat R. : "Computerized Management Information Systems and Organizational Structure", Sloan School of Management Working Paper, 1970.

A highly theoretical paper which suggests "a framework and a set of rules for classifying organizations by relative structure", and infers the impacts of information technology on organizational structure through "the most critical factors that favor centralization and decentralization".

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